Exhibit 3

Using the Internet Protocol suite to build an end-end IPTV service

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A Video Distribution Network based on IP

- AT&T has chosen to build a video distribution network on top of an end-end IP infrastructure
- Alternative approaches adopted by Cable providers and Verizon with FTTH
  - Use IP in the backbone, but seek to use the capacity of the access plant downstream to have a Layer 2 environment
    - Use the bandwidth to distribute channels and depend on "tuning" to access a particular channel
- Having an end-end IP distribution offers both opportunities and challenges
  - Enables integration of multiple applications; evolving from a linear-TV distribution to content distribution may be easier
  - Challenges arise: packet loss and recovery; congestion; channel change

IPTV service

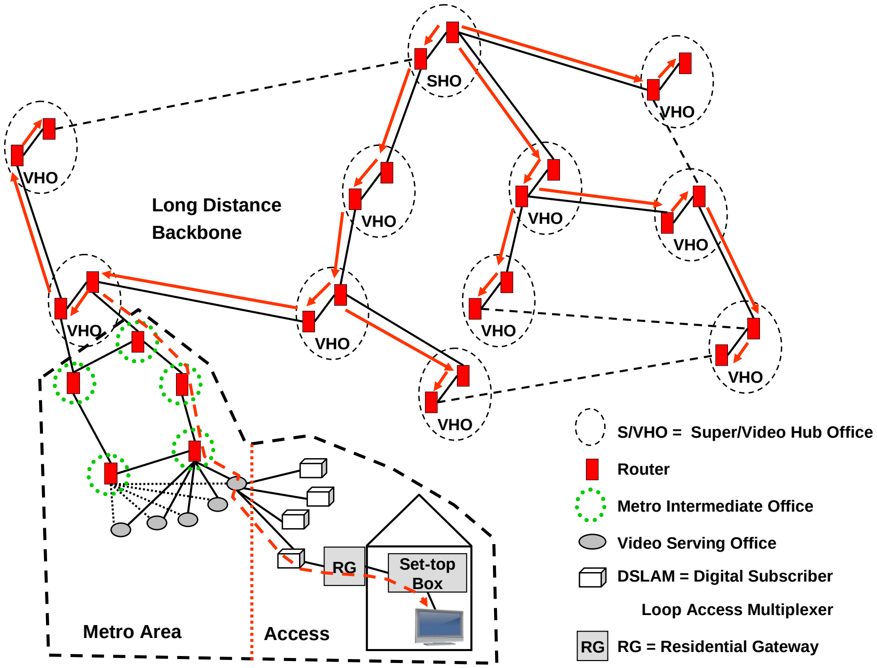
- High visibility: direct customer impact.
- Service is very sensitive to delay and packet loss
  - Congestion on links -> packet loss-> video quality impairment
  - Need to tackle multiple failures, which are not very rare
  - Higher layer mechanisms - FEC, retransmission based recovery of lost packets - can handle (with reasonable delays), burst losses of 50 milliseconds
    - Fast restoration is critical

AT&T's IPTV service:

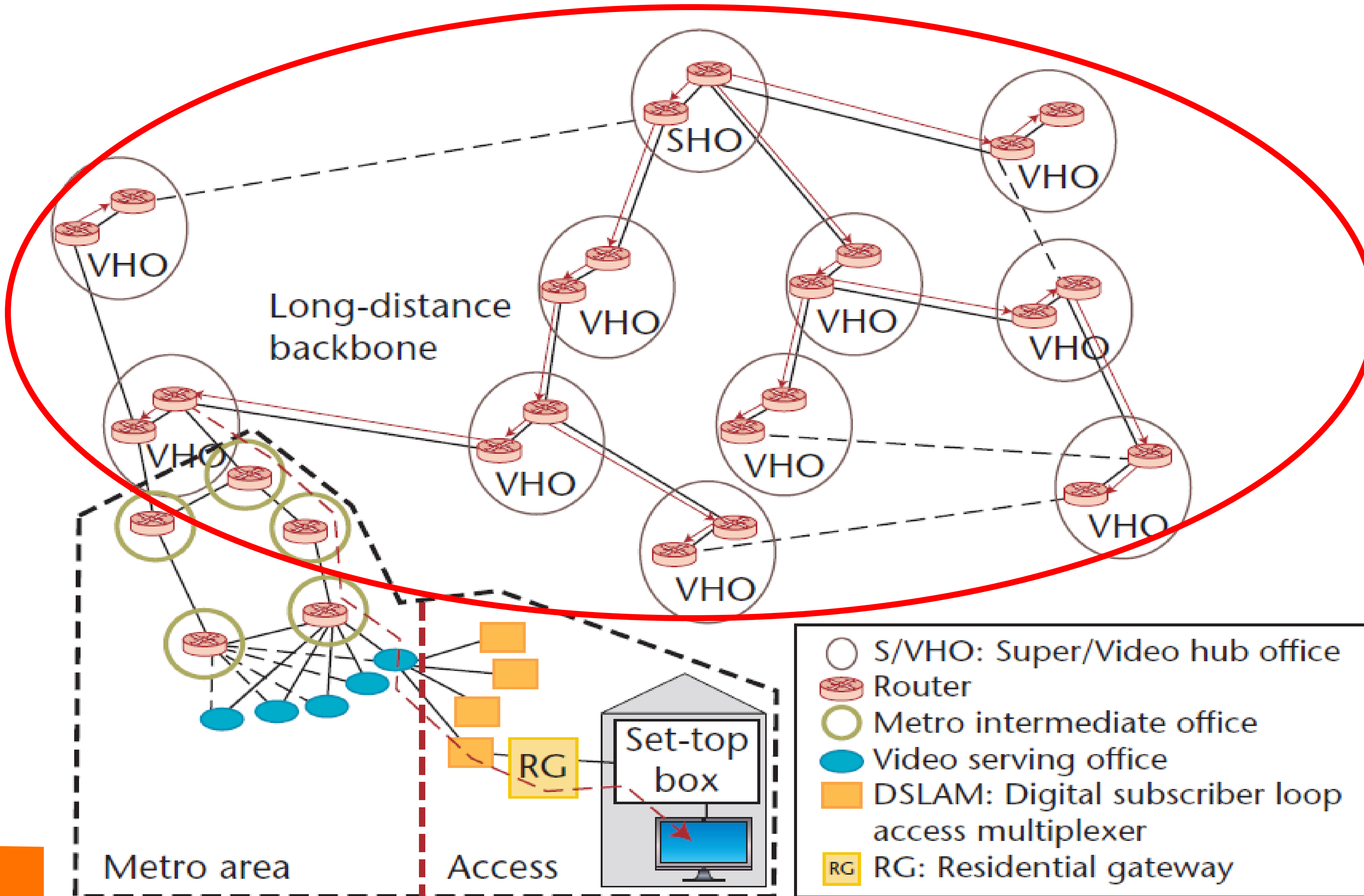
- 2+ million customers;
- Triple play: video, internet, and voice

Network backbone

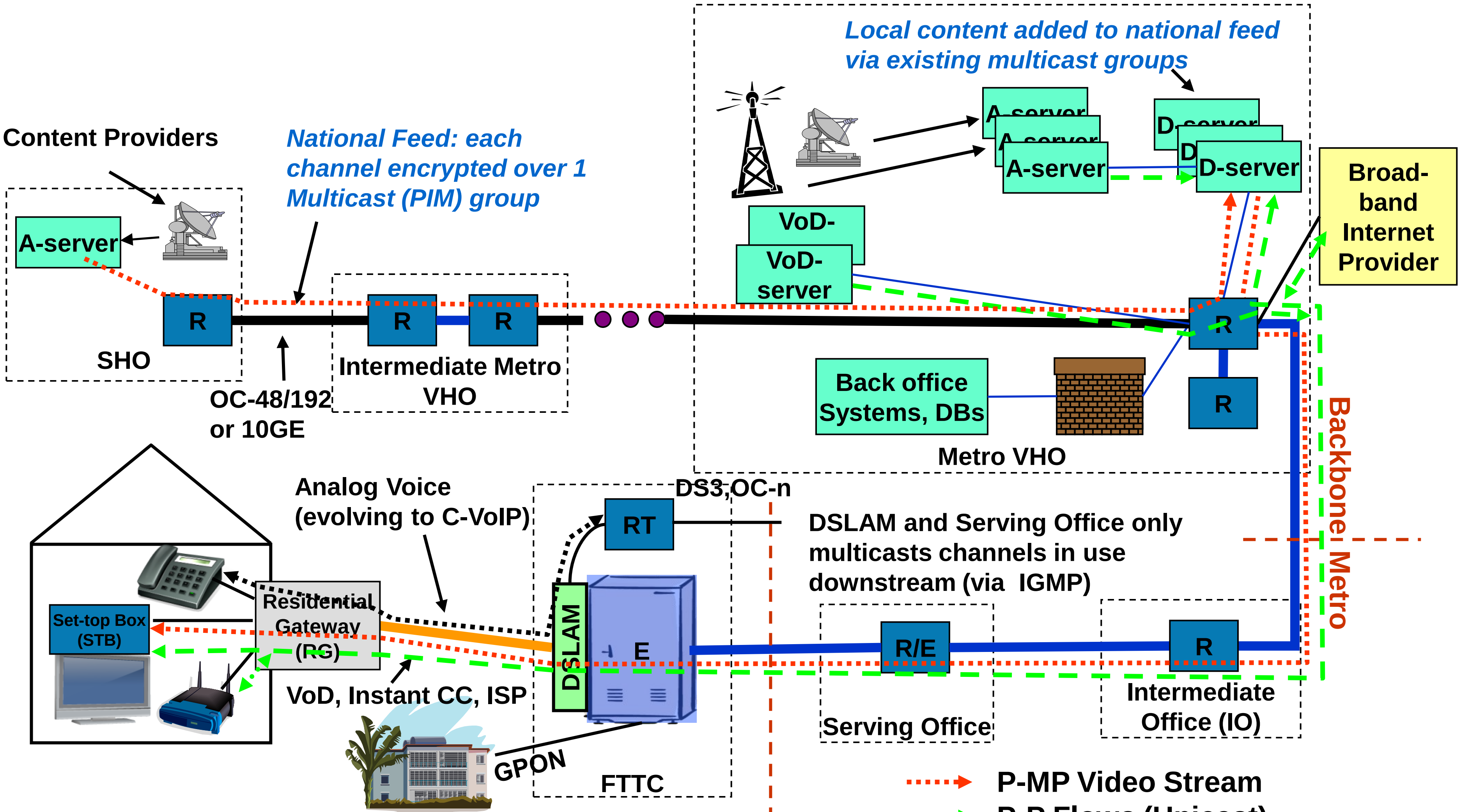
- One Video hub office (VHO) per metro area
- Content is distributed to VHOs using single source sparse mode multicast (PIM-SSM)
  - a separate multicast tree for each channel



AT&T IPTV Backbone Distribution InfraStructure



IPTV Network – Example End-to-End Flow



R = Router; E = Ethernet Switch; R/E = Hybrid
GPON = Gigabit Passive Optical Network
SHO = Super Hub Office; VHO = Video Hub Office
IGMP = Internet Group Management Protocol

Some Network Characteristics for Providing IPTV

- Streaming video national video stream generally uses MPEG-X for compression/encoding over RTP
  - Use of IP Multicast (PIM-SSM) when possible from SHO to VHO and VHO to IO enables significant transport cost savings
  - Ethernet switches use Internet Group Management Protocol (IGMP)-snooping to change channels and bridge multicast groups to VLANs
- ***Perceived video quality is not highly tolerant of loss***. Example approach:
  - L1/L2 protocols restore vast majority of network failures ≤ 50 ms
  - STB & reliable transport layer protocols to overcome failures ≤ 50 ms
- Instant Channel Change (ICC) popular feature to overcome delay in Multicast group/IGMP change
  - Typically implemented via Unicast IP flow (point-to-point)
- VoD is usually unicast from VHO to STB

What transport service does an app need?

Data loss

- some apps (e.g., audio) can tolerate some loss
- other apps (e.g., file transfer, telnet) require 100% reliable data transfer

Timing

- some apps (e.g., Internet telephony, interactive games) require low delay to be "effective"

Throughput

- some apps (e.g., multimedia) require minimum amount of throughput to be "effective"
- other apps ("elastic apps") make use of whatever throughput they get

Security

- encryption, data integrity, …

Transport service requirements of common apps

Application	Data loss	Throughput	Time Sensitive
file transfer	no loss	elastic	no
e-mail	no loss	elastic	no
Web documents	no loss	elastic	no
real-time audio/video	loss-tolerant	audio: 5kbps-1Mbps video:10kbps-5Mbps	yes, 100’s msec
stored audio/video	loss-tolerant	same as above	yes, few secs
interactive games	loss-tolerant	few kbps up	yes, 100’s msec
instant messaging	no loss	elastic	yes and no

Internet transport protocols services

TCP service:

- *connection-oriented:* setup required between client and server processes
- *reliable transport* between sending and receiving process
- *flow control:* sender won't overwhelm receiver
- *congestion control:* throttle sender when network overloaded
- *does not provide:* timing, minimum throughput guarantees, security

UDP service:

- unreliable data transfer between sending and receiving process
- does not provide: connection setup, reliability, flow control, congestion control, timing, throughput guarantee, or security

Q: why bother? Why is there a UDP?

Internet apps: application, transport protocols

Application	Application layer protocol	Underlying transport protocol
e-mail	SMTP [RFC 2821]	TCP
remote terminal access	Telnet [RFC 854]	TCP
Web	HTTP [RFC 2616]	TCP
file transfer	FTP [RFC 959]	TCP
streaming multimedia	HTTP (eg Youtube), RTP [RFC 1889]	TCP or UDP
Internet telephony	SIP, RTP, proprietary (e.g., Skype)	typically UDP